Draft Proposed Monitoring Program to Determine Extent of WTC Impact

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BACKGROUND: This proposal is the result of ongoing efforts to monitor the situation for residents and workers impacted by the collapse of the World Trade Center (WTC) towers. In March 2004, EPA convened an expert technical review panel to guide and assist the Agency in its use of available exposure and health surveillance databases and registries to characterize any remaining exposures and risks, identify unmet public health needs, and recommend any steps to further minimize the risks associated with the aftermath of the WTC attack.

The WTC Expert Technical Review Panel has met six times in open meetings to interact with EPA and the public on plans to monitor for the presence of WTC dust in indoor environments and to suggest additional evaluations that could be undertaken by EPA and others to evaluate the dispersion of the plume and the geographic extent of environmental impact from the collapse of the WTC towers.

The panel was charged, in part, with reviewing data from post-cleaning verification sampling to be done by EPA in the residential areas included in EPA's Indoor Air Cleanup and to verify that recontamination has not occurred from central heating and air conditioning systems. With the assistance of Westat, a contractor in the field of statistics, EPA developed a sampling plan to evaluate whether apartments previously cleaned in EPA's Region 2 clean and test program had become recontaminated. The EPA proposed plan was debated by the panel, and most panel members believed that an alternate study to test for "contamination" rather than "recontamination" should be conducted instead.

Using a peer review contract, EPA solicited expert comment from non-panel experts on the use of asbestos as a surrogate for determining risk from other contaminants and provided a report on those comments back to the panel. The external reviewers generally supported the use of asbestos as a surrogate, but encouraged the concurrent testing for lead.

Many members of the panel did not support the position that asbestos was an appropriate surrogate in determining risk for other contaminants, and instead discussions have led to the concept that a WTC signature exists in dust and that sampling could focus on determining the presence of that signature, as well as the levels of contaminants of potential concern. That signature has been identified in numerous outdoor dust samples, and efforts are underway to confirm its presence in the indoor environment.

The panel is reviewing the ongoing work by the federal, state and local governments and private entities to determine the characteristics of the WTC dust plume and where it was dispersed, including the geographic extent of EPA and other entities' monitoring and testing, and recommending any additional evaluations for consideration by EPA and other public agencies.

EPA developed an alternate sampling plan to evaluate the presence and levels of contaminants of potential concern in buildings in lower Manhattan, including contaminants that could be markers for WTC dust. A primary objective of this study will be to determine the geographic extent of WTC dust, and plans call for sampling beyond Canal Street to as far north as Houston Street in lower Manhattan. To the extent possible, the sampling results will also be used to determine the geographic extent and impact of the fire plume residues.

The following proposal replaces earlier draft proposals made by EPA. A cornerstone of this proposal is the existence of a reliable signature for WTC dust and/or combustion products.

OBJECTIVES: Concurrent efforts have the following objectives –

(1) To estimate the geographic extent of WTC contaminants of potential concern (COPCs) resulting from the building collapse and fire plume by surveying residential and non-residential buildings in lower Manhattan that volunteer to participate. Sub-objectives will be to relate results of the survey to building cleaning history and to the role of central heating, ventilation, and air conditioning (HVAC) if the information collected will support such an analysis;

(2) To provide the data necessary to determine if a Phase II sampling should proceed, which will test for the presence of collapse and fire plume residues in areas beyond the boundaries of the areas currently tested, and to provide the data necessary to determine whether and what further actions are warranted; and

(3) To validate a method to identify a signature for WTC dust and/or combustion products.

APPROACH:

I. GEOGRAPHIC EXTENT SURVEY

A. <u>Overview</u>: The primary objective of this sampling program will be to estimate the geographic extent of WTC collapse and fire plume residues in a sample of buildings that volunteer to participate. Success in meeting this objective is contingent on developing a "signature" for WTC dust residue and the availability of a sufficiently large list of candidate buildings (referred to as the 'sample frame') to provide sufficient coverage of the area to be studied. If sufficient volunteers are not forthcoming, it may not be possible to determine the extent of contamination with an adequate degree of confidence. Secondary objectives include ascertaining the relationship between measurements and building cleaning history and ascertaining the role of HVACs in the potential recirculation of WTC dust. Based on evaluation of the results, a second phase of sampling may then extend into other areas.

The intent is to characterize entire buildings by sampling a number of units within each building selected. The area of sampling extends throughout lower Manhattan to Houston Street, an area roughly double the size of the area included in the initial dust cleanup program. The "target population" of buildings includes all "public" and "private" buildings that volunteer to participate. Public buildings are defined as buildings which are occupied by public institutions, such as schools, firehouses, public housing, and buildings housing government offices. Private buildings include apartment buildings and private office/commercial buildings. For purposes of the objectives stated above, these buildings can also be characterized with regard to potential exposures – whether they are residential or non-residential, and non-residential mostly denotes buildings that house commercial or workplace environments. A "list" of buildings will be compiled including all buildings that volunteer to participate in the survey. Complete participation in this survey is required, meaning that a sufficient number of units within these buildings must be made available for sampling. Only with this level of participation can the survey be characterized as a "building survey" (in contrast to an apartment survey, an office survey, or a different survey with a smaller sampling unit). As discussed below, a procedure to sample numerous "units" within the building will allow for a complete building characterization.

B. Sampling Design: A statistical approach referred to as spatially balanced sampling will be used to select a sample of buildings from the list of all eligible buildings. Spatially balanced sampling was developed as a powerful and flexible technique for selecting spatially well distributed probability samples with wide application to sampling of environmental populations. The methodology is described in Stevens, D. L., Jr. and A. R. Olsen (2004). "Spatially-balanced sampling of natural resources." *Journal of American Statistical Association* 99(465): 262-278. The spatially balanced sampling methodology has been applied successfully to the sampling of lakes, rivers and streams and other environmental sampling applications in which selection of a probability sample that provides balanced coverage over a specified geographic area is required.

The buildings to be sampled in lower Manhattan constitute a finite population of distinct units that occupy fixed locations specified by two-dimensional coordinates. The geographic coordinates for each building are the key to sample selection process. The building coordinates are transformed mathematically to create an ordered spatial address for each building which then becomes the basis for selecting buildings to be sampled via the spatially balanced random selection procedure.

The sample design can be adjusted to accommodate a variety of sampling objectives and requirements. For example, categories of distance from the WTC site can be used to stratify the population and sampling can be designed to have equal numbers of buildings per category or proportional sampling by category. Different categories of buildings are possible such as building type, cleaning status or HVAC category. If stratifying based on building characteristics other than distance from Ground Zero is possible, then it may be implemented. However, the main objective of the current sampling program is to support estimates of "geographic extent."

In order to implement a spatially balanced sample selection for the lower Manhattan area, the following must be accomplished:

(1) Identify the geographic area for sampling: Figure 1 shows the location of key areas where an analysis by EPA's Environmental Photographic Interpretation Center (EPIC, 2004) determined the extent of deposition of WTC dust and debris. The ground dust/debris boundaries in Figure 1 were derived from the analysis of multiple images taken between September 11 and September 13, 2001. This is the area that EPA believes was most heavily impacted by the dust generated when the towers collapsed. As can be seen in Figure 1, "confirmed dust/debris" areas extend to approximately Chambers Street, "probable dust/debris" areas extend to approximately Canal Street, and "possible dust/debris" areas extend to approximately Spring Street on the West side near the Holland Tunnel. Figure 2 displays this area in lower Manhattan on a color-coded map, and based on this analysis and public input, EPA has designated the area beneath Houston Street to be included in the sampling. Houston Street is shown in Figure 2 as a dashed line.

(2) Identify buildings eligible for sampling: Efforts are underway to develop a list of eligible buildings. EPA is working with New York City and others to identify public buildings which will allow EPA access for sampling. Concurrently, EPA and the WTC Panel's Community Participation Committee have begun a Community-Based Participatory Research effort to provide a formal mechanism for community input into the planning and design of project protocols and research and to help enlist participants for this building survey. These efforts will result in a list of residential and non-residential buildings which will be eligible to be selected for the survey.

An important qualifier to this list of buildings is that there will be a building self-selection bias built into this survey. A "self-selection bias" is defined as the bias introduced because the survey participants will volunteer, rather than be randomly selected from all possible survey participants. Self-selection could result in a non-representative sampling. It is expected that the efforts to enlist public and private buildings will be successful and that the list of eligible buildings will include a cross section of building types, and there will be a sufficient geographic spread of buildings.

Once this list is complete, building selection can proceed. There may be a desire to enter a second stratum variable to the survey at this point (i.e., building type). For example, there may be a desire to guarantee a sufficient size of apartment buildings in a survey. If so, then building selection would consider not only spatial coverage, but a concurrent desire to guarantee a sufficient sample size of specific building types. This option can be considered once the list of eligible buildings is complete.

(3) Construct the spatially balanced sampling frame: The sampling frame (i.e., the list of buildings from which the sample is to be drawn) will be comprised of the buildings that volunteer to participate. The buildings will be located within the area to be sampled by their coordinates and stratified by distance from the WTC site. The number of distance categories and number of samples per category will be determined once the final list of eligible buildings is determined. The spatially balanced sampling methodology will be used to select the sample as described by Stevens and Olsen (2004).

Alternative stratifications of the sample population will be explored in the process of constructing a sample. For example, Figure 2 shows the lower Manhattan area bounded by Houston Street with regard to the EPIC results with confirmed dust/debris areas in red; probable dust/debris areas in orange and possible dust/debris areas in pink. These area designations could be combined with distance categories to create an effective stratification of the population. The distance stratification can be constructed to form what are, in effect, concentric circles around the WTC site while the dust/debris categories would insure that sufficient sample coverage in these areas is obtained. Figure 3 displays a possible outcome of applying this spatially balanced approach using distance categories as suggested. The squares and crosses in the figure are hypothetical buildings situated around Ground Zero at varying distances. The squares are buildings that might comprise the final set of buildings to sample, and the crosses identify other eligible buildings that were not selected. The black square/crosses are the nearest category at 0 to 500 meters from Ground Zero, while the green are the furthest category at 1500 to 3000 meters. It is seen from this figure that good geographic coverage in lower Manhattan in all directions is achieved. Other possible stratification factors such as building type can also be explored but all of these considerations are highly dependent on the number and location of volunteer buildings.

C. <u>Approach to Building Characterization</u>: In order to gain sufficient coverage of each building, one "unit" for every two floors will be sampled. Therefore, taller buildings will receive more representation in the results in terms of numbers of samples. Adjustments may be required to account for location so that buildings with more data do not misrepresent spatial patterns. A "unit" generally denotes a reasonably small, confined and well defined area that will be different for each building and building type. For example, a unit within a school could be a classroom, within a residential building could be an apartment, and within an office building could be an area including several cubical and private offices. Priority in unit selection will be given to the units closest to Ground Zero (i.e., the ones most nearly facing Ground Zero) and to units served by HVAC systems. Two sets of dust samples will be taken within each unit: 1) locations where dust-related exposures are likely to occur, such as in elevated horizontal surfaces (e.g., desk or table tops) and floors, and 2) locations where WTC dust may have accumulated but not necessarily cleaned, such as behind or on top of cabinets (results from these samples will be used only to help answer the geographic extent question). Wipe samples as well as microvac (using method ASTM D 5755-95) samples will be taken. Wipe samples will be taken from non-porous surfaces such as table tops, and microvac samples will be taken on porous surfaces such as rugs or fabric furniture. Enough sample volume will be taken so that contaminant analysis can measure for what are anticipated to be WTC signature contaminants, as well as other contaminants of potential concern (COPCs; see overview below).

D. <u>Contaminants of Potential Concern (COPCs)</u>: COPCs will be measured in dust samples. They are shown below with their risk-based benchmarks and information on background levels:

COPC	Matrix	Health-Based Benchmark	Occupational Limit	Residential WTC Background Study
asbestos	settled dust	N/A*	N/A	2,783 f/cm^2 (microvac) 37,174 f/cm^2 (wipe)
MMVF	settled dust	N/A**	N/A	38 f/cm^2
crystalline silica	settled dust	N/A***	N/A	N/A
PAHs	settled dust	150 ug/m^2	N/A	< 290ug/m^2
Lead	settled dust	25 ug/ft^2	N/A	4 ug/ft^2 (uncarpeted floors)

N/A - Not Available

* To be determined. Because asbestos is primarily an inhalation toxin, a risk-based benchmark for settled dust would need to be well-correlated to an indoor air concentration. The relationship between asbestos in settled dust and indoor air is influenced by many factors (e.g., activity patterns, surface texture, room volume, air-exchange rates, fiber dimension) and is, consequently, highly variable. Thus, the development of a risk-based benchmark for asbestos in settled dust would have a high uncertainty factor. Consequently, the proposed benchmark for asbestos in settled dust is based on a comparison to the background concentration of asbestos in residential urban settings. To inform decisions of this type, EPA previously conducted a WTC Background Study (available at www.epa.gov/wtc). Background samples were obtained by two methods: microvac and wipe. The average (mean) value for 161 microvac samples was 2,783 f/cm^2; the mean value for 146 wipe samples was 37,174 f/cm^2. The value obtained by microvac sampling (2,783 f/cm^2) appears consistent with values published in the ASTM "Experience Standard" for evaluating asbestos hazards in settled dust. The ASTM standard is specific to samples obtained by the microvac method (ASTM D 5755-95). It states: 1,000 f/cm^2 = "low"; 10,000 f/cm^2 = "above background"; 100,000 f/cm^2 = "high." The Superfund Hazard Ranking System (HRS Guidance Manual - November, 1992) considers contaminants site-related for National Priority List scoring when they are three times above site-specific background. Consequently, a benchmark of 8,000 f/cm^2 (a rounding of 2,783 f/cm^2 x 3) is proposed for asbestos in settled dust based on a comparison with site-specific background data. This value is specific to samples obtained by the ASTM D 5755-95 method. Samples obtained by a wipe method should be similarly compared to the site-specific background value obtained by that same sampling technique. The WTC asbestos benchmark is also within the range of the ASTM "Experience Standard" that is bounded by levels that are "low" and those that are "above background."

** Not applicable. Although it is also a contact irritant, MMVF, like asbestos, is mainly an inhalation toxin. Therefore, a risk-based benchmark for settled dust needs to be well-correlated to an indoor air concentration. The uncertainties attendant in predicting an asbestos air concentration based on settled dust measurements apply equally to MMFV. In addition, there is a paucity of studies in the scientific literature directed at characterizing background loads (fibers per unit area) of MMVF in settled dust in the indoor environment. Consequently, a benchmark for MMFV in settled dust will need to be developed based on a background level for MMVF

*** Not applicable. Neither the peer review draft nor the final version of the COPC report proposed a health-based benchmark for silica in settled dust. Like asbestos and MMVF, silica is primarily an inhalation toxin. The benchmark for silica in indoor air is based on detection limits. Therefore, a health-based benchmark for silica in settled dust, based on a relationship between settled dust and air concentrations, is not applicable. Therefore, like asbestos and MMVF, a benchmark for silica will be based on background levels in dust.

The settled dust benchmarks for lead and polycyclic aromatic hydrocarbons (PAHs) were developed as part of the EPA Region 2 Indoor Air Cleanup program. They were developed using a risk assessment approach and were peer-reviewed.

Lead (Pb), which can cause serious learning disabilities and behavioral problems in children, is commonly found in the air, water, soil and indoor dust of the urban environment, as well as in people's diets. It is often present in older housing that may contain lead-based paint. According to HUD data, about five percent of the housing stock in the Northeast has lead levels above the 25 $\mu g/ft^2$ benchmark. In buildings constructed before 1939, more than ten percent exceed 25 $\mu g/ft^2$. This factor makes it difficult to distinguish between lead from WTC dust and other sources, especially in older buildings. However, sampling and analyses for lead will be conducted. All findings will be reported to owners and occupants. If elevations are found, referrals will be made to the New York City Department of Health and Mental Hygiene, and owners and occupants will be apprised of options for dealing with the finding.

It is important to note that dioxin has also been identified as a WTC COPC, but it is not on the list. Dioxin is a ubiquitous urban contaminant, so attributing dioxin findings to WTC is difficult. Second, dioxin dust sampling during EPA's Indoor Air Cleanup program in 2002 found very little dioxin in apartments in the cleanup zone. Of 538 dust samples taken in 262 apartments, only 8 samples (or 0.5%) showed a level greater than the dust standard developed by EPA Region 2 of 2 ng TEQ/m^2 . (TEQ is an acronym for Toxic Equivalents which is a summary measure of toxicity for dioxins.) Furthermore, dioxin levels found were not significantly different from levels in the background study. The single high outlier of 75 ng TEQ/m^2 was found on a mantel over a fireplace; given that dioxins are a product of incomplete combustion, an elevated level above a fireplace is not unexpected.

The concurrent WTC signature effort discussed below is currently targeting various glass fiber types and PAHs as possible signature compounds to identify WTC dust and combustion by-products, respectively. Before any samples are taken, the WTC Signature Subgroup will provide information on the necessary sample volume and analytical methods which will allow for the measurement of the dust and air samples for the signature compounds with an appropriate level of detection.

E. Analytical Methods and Sampling Protocols: These are shown in Table 1. These are the methods and protocols that were used in EPA's background and confirmation cleaning study.

F. Heating, Ventilation, and Air Conditioning (HVAC) Sampling: In order to characterize central HVAC units in buildings which have full or partial central HVAC units ("full" defined as units serving both common areas and individual apartments, offices, etc; while "partial" is defined as units serving only common areas while apartments or offices have individual units), microvac samples will be taken in: 1) outdoor air inlet to HVAC; 2) air mixing plenums serving sampled floors; and 3) HVAC outlet discharging to locations where COPC samples are taken. Additionally, HVAC filters will be sampled. While all samples may be informative with regard to WTC impact, it is expected that the last noted sample location (where the HVAC discharges to where COPC samples are taken) may be the most informative with regard to elucidating the role HVAC systems have on recirculating WTC contaminants to exposure areas.

G. Data Analysis: The indoor sampling program outlined in this proposal will provide data that will be the basis for decision-making on whether to extend the area for sampling to determine the extent and magnitude of WTC dust presence. This information is also key to determining what further cleaning activities in lower Manhattan might be appropriate. This section outlines the decision process that will be used to determine whether levels of WTC contamination found during this sampling program are sufficient to merit cleanup of either the unit (commercial or residential) being sampled within a building or the whether the entire building being characterized should be offered an opportunity for cleanup.

There are two sources of information that can contribute to the decision-making process. These are the measurements of contaminants of potential concern and the "signatures" of WTC building debris dust and combustion products. At this point in time, the existence of "signatures" and validated methods for their identification has yet to be demonstrated although early work on both of these signatures is promising. This signature validation will proceed in parallel with the sampling program for contaminants of potential concern. The criteria for "success" in validating the WTC signature has not been laid out, but certainly these components must be present: 1) it must be clearly defined - the candidates to date appear to be various glass fiber types for the building collapse and a particular PAH congener profile for the fire plume; 2) there must be evidence that the signature was found indoors in settings likely impacted by WTC collapse or emissions; and 3) there must be evidence that it is not at background locations distant from the WTC. The WTC Expert Technical Review Panel will be used to develop and review the WTC Signature Study.

The signature study is fully successful in identifying a signature in indoor dust that can be reliably tied to the building collapse.

Where COPCs exceed "cleanup benchmarks" a cleanup will be offered the owner or occupants for those units or buildings sampled that have the COPCs associated with dust from the WTC. Typically, EPA would base decisions on cleanup against health-based benchmarks for concentrations of COPCs. Those health-based benchmarks are usually the concentrations of these contaminants in air. In this sampling program, the method for determining concentrations of COPCs will be by wiping hard surfaces or vacuuming porous surfaces for settled dust. This has been the preferred approach for many groups in the community affected and for many members of the Expert Panel. The amount of research necessary to establish health-based benchmark concentrations in dust for the remaining decision-making COPCs precludes pursuing their derivation if the sampling program is to proceed in a timely manner. Thus, health-based benchmarks will not be available for evaluating the extent of WTC contamination and its impact, except for PAHs where a health-based benchmark for concentration in settled dust has been developed. In the absence of health-based benchmarks for the evaluation of concentrations of COPCs in the sampling program, EPA will have to establish "cleanup benchmarks."

In this instance the decision criteria will be based on COPC benchmarks and how they compare with the indoor sampling results. One option for establishing these "cleanup benchmarks" is to establish them at three times background levels for the particular COPC. Precedent for this approach is found in the criteria used in screening sites for possible inclusion in the National Priority List for Superfund. Based on the Background Study conducted by EPA Region 2 in 2002, a value of 38 f/cm^3 was found for man-made vitreous fibers (MMVF). The benchmark level will be 114f/cm^3. A background value for silica in dust has not been determined, either in the literature or as part of the Background Study conducted by Region 2 in 2002. Buildings near Ground Zero and background buildings are currently being sampled as part of the WTC Signature Study, and these results will be used to establish a background for silica. Results of this work will also be helpful in elaborating on the background levels of other COPCs. The WTC Expert Technical Review Panel will be used to review possible cleanup benchmarks and review the information generated on background levels of COPCs from the WTC Signature Study.

While a health-based benchmark for lead in settled dust was developed by Region 2 for use in the 2002 Indoor Air Cleanup Program, the ubiquitous nature of lead in the urban environment makes its utility for evaluating WTC dust presence negligible. Sampling below Canal Street revealed a relatively large number of exceedances of this benchmark. This is not unexpected as only about 15% of the buildings below Canal Street were built after 1950 (when local law banned the use of lead paint). Community District 3 (East side) is similar in age distribution to the area below Canal. However, less than 7% of the buildings in Community District 2 (West side) were built after 1950. Because the number of exceedances found in 2002 was what one would expect in buildings of this age and because no spatial pattern that was related to the WTC was observed, the lead exceedances we found and expect to find are not attributable to the collapse of the WTC. This benchmark will be used to trigger a notification to owners and occupants of the presence of lead, and similar procedures used for lead in the 2002 EPA Indoor Air Cleanup Program will be followed. EPA will recommend that owners or occupants make follow-up efforts including: 1) efforts to ascertain the source of lead, ranging from visual inspection to building records to XRF analysis, and 2) reporting of the finding to the local health department for appropriate action.

Figure 4 displays a decision tree for this evaluation. It is assumed that the signature validation study is completed and has been successful in identifying either, or both, the building collapse and the fire plume signature.

Other observations from this decision tree include:

(1) For a sampled unit that is in a workspace, the health-based benchmark that could be used is an OSHA standard such as the Permissible Exposure Level (PEL) or other appropriate standard.

(2) The proposed decision criterion for a judgment relating to full building cleanup involves the use of a 95% Upper Confidence Limit (UCL) standard. An Upper Confidence Limit (UCL) for an estimated mean value is a measure of uncertainty due to sampling, measurement and other sources variability in a set of data. The 95% UCL defines a value that estimated means would exceed approximately 5% of the time in repeated sampling. The 95% UCL is commonly employed in EPA hazardous site assessments to provide a conservative upper bound estimate on the average site-wide contaminant level. The UCL will be used in the decision process as follows: If the 95% UCL for the estimated building mean exceeds the benchmark value for a COPC, then this may be considered to provide support for the decision to clean the building.

If the signatures are not identified or their use proves unreliable, the decision for sample unit cleanup will have to rely on the levels of contaminants of potential concern alone.

The absence of a WTC signature may make it very difficult to determine the geographic extent of WTC dust and whether any exceedances of COPCs are related to the WTC collapse. In the absence of a measure that can identify WTC dust or combustion products signatures, the WTC Expert Technical Review Panel and the Community-Based Participatory Research planning group will be asked to evaluate the overall results of the sampling program and provide EPA with their interpretation of the results. These interpretations will be used by EPA, along with its own analysis of the sampling results, to make recommendations about sampling unit cleanups, expansion of the sampling areas, or more general cleanup activities.

II. WTC SIGNATURE VALIDATION STUDY

The purpose of this study is to develop and validate one or more “signatures” in indoor dust that can be used to determine whether dust sampled as part of EPA’s planned sampling program can be attributed to collapse of the WTC towers or is of a different origin. A “signature” is a chemical or physical characteristic of a material that can be used to identify that specific material and discriminate between the material sought (WTC dust, in this case) and other similar materials (New York City urban dusts). The specific methods or chemicals used to decide the dust’s origin are not necessarily related to health concerns. The signature could be something totally innocuous but unique to the WTC source, measured only to identify the origin of other chemicals of concern that occur in the same sample.

The collapse of the WTC towers produced many tons of airborne dust, and this dust spread over a wide area of lower Manhattan and beyond. The fires from the WTC site burned for many weeks after the collapse, and emissions from these fires were carried by the wind to areas across New York City and perhaps beyond. Although some buildings were cleaned through an earlier effort by EPA and others, there are health-related concerns about WTC dust that may still remain inside buildings in the NYC area. In order to remove residual dusts from indoor areas, it is necessary to identify the areas still contaminated with WTC dusts. The WTC signatures, if they can be developed, will support analysis to discriminate between normal indoor dusts and WTC-generated dusts, to aid in identifying the areas for cleanup.

Because of the different materials in the dust cloud from the initial collapse of the buildings and the smoke plume generated by the subsequent fires, two different types of signatures - building collapse and WTC smoke - will be sought for these two different types of airborne particles. In both cases, for the building collapse and for the fires, the signatures need to be: 1) unique to WTC dusts (distinct from urban dusts); 2) persistent for many months (not volatile); 3) homogeneous in WTC dust (evenly distributed through samples of WTC dust); 4) able to be detected with small sample size, low minimum detection limit, and low interference from other dust components; and 5) consistently found in impacted areas. To facilitate the analysis of the hundreds of samples from areas across the greater NYC area, the analysis methods for these signatures should preferably also be low cost, available through commercial laboratories, relatively rapid, and should employ automated assay methods.

The dust cloud from the building collapse contained a mixture of finely pulverized building materials. Scientists at the United States Geological Survey (USGS) Laboratories in Denver, Colorado are using electron microscopy and chemical analysis methods (SEM-EDS) to identify and characterize hundreds of individual particles in samples collected soon after September 11. Although the major, minor and trace components of WTC dust are well documented, these components have not been systematically evaluated for the purpose of identifying trace levels of WTC contamination in indoor dust. A variety of samples of bulk dust will be analyzed to estimate relative concentration levels of as many key components as possible. These analyses will use point counting methods developed at the USGS for EPA Region 8. Results will be tabulated according to sample location. Factors such as distance from source and elevation will be evaluated. COPCs will also be analyzed to determine the quantitative relationships between signature components and COPCs.

In addition to the analysis of bulk WTC dust, background samples will be analyzed to verify that signature components are not present at levels that would compromise the use of the signatures in identifying WTC dusts. Background samples are critical to any analysis program, including this study and any new sample collection and analysis program for COPCs. The only way to demonstrate that contamination is from the WTC is to show the absence of key components (alone or in combination) in background.

From preliminary work, the materials that might be used as a signature include a variety of glass fiber types (slag wool, mineral wool, and soda-lime glass) possibly in combination with concrete and/or gypsum. This careful microscopic analysis will set the framework for selecting a chemical and/or particle shape-related (e.g., fiber shape) signature and for the possible subsequent development of automated analysis methods for a building collapse signature.

Scientists at Rutgers University, EPA's Office of Research and Development, and the University of North Carolina are working to develop fire emissions signatures. Signatures proposed for the fires include:

A. Pattern of organic chemicals in dust particles: The WTC fires produced a complex mixture of organic chemical emissions. Analysis of fine particle samples from several contaminated and uncontaminated sites show a pattern of different organic components that might be developed as a signature for the fires.

B. Ratio of specific polycyclic aromatic hydrocarbons (PAHs): PAH compounds, carbon-containing chemicals with more than one benzene ring in each molecule, are formed when carbon-containing materials are burned. Some of these PAH compounds appear to be found at greater concentrations in WTC dusts, as compared to dusts from areas outside the fire plumes. A trace analysis method is being developed, focusing on the ratios of selected PAHs.

C. Total organic carbon: When carbon-containing materials are completely burned or oxidized, they produce carbon dioxide. The WTC fires smoldered for several months, producing many species of partially oxidized carbon-containing compounds. In a recent EPA study, the total organic carbon (TOC) content (indicative of smoldering fire) of samples of WTC-associated dusts was higher than the TOC content of indoor dusts from uncontaminated areas in NYC.

D. Brominated organic compounds: Fire retardants used in the WTC contained bromine. During the fires, these bromine-containing compounds would have burned, possibly producing bromine-containing particles. This hypothesis has not been tested with contaminated and uncontaminated samples.

A program to acquire indoor dust samples to assist in the development and evaluation of WTC dust signature is underway. The first set of samples has been obtained from a contaminated building next to the WTC site. Dispersion models, photos, interviews and satellite data will be reviewed to discern areas that were probably impacted by WTC emissions. Samples from 20 buildings will be collected for validation of the proposed signatures. Samples will be collected from 10 buildings in the area that is suspected to be affected by WTC emissions, and samples will be obtained from 10 buildings that are not suspected of being affected. In each building identified for sampling, dust samples will be collected from at least three areas: 1) one sample from a track-in area near a building entrance, preferably in a carpeted area; 2) two samples from relatively undisturbed areas (e.g., on top of bookcases, under furniture); and 3) other areas showing visible accumulation of settled dust, including HVAC ducts. A standard method using a HEPA vacuum collector will be used by EPA to collect bulk dust samples. Samples will be sealed and stored under refrigeration in a limited access area.

To ensure that these important samples are properly collected, tracked, stored, and distributed, comprehensive quality assurance (QA) procedures will be in place prior to any sample collection. There will be a survey of building and sampling areas, to include photos of sampling areas (if permitted by building owners) and notes on building usage, to identify conditions that might compromise samples (e.g., smoking or cooking areas).

Samples will be analyzed for the proposed signatures and for the contaminants of potential concern (COPCs) as identified by the WTC Expert Panel. The results of these analyses will be made available as soon as possible after EPA has reviewed the data for QA. The sampling for background dust and WTC dust is targeted for completion by the middle of November 2004. This could be delayed if obtaining access to appropriate sampling locations becomes an issue. EPA will proceed with signature development and analysis as rapidly as possible and will release these results to the WTC Expert Panel and the public for use in the larger sampling plan as soon as possible.

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Stevens, D. L., Jr. and A. R. Olsen (2004). Spatially-balanced sampling of natural resources. Journal of American Statistical Association 99(465): 262-278.

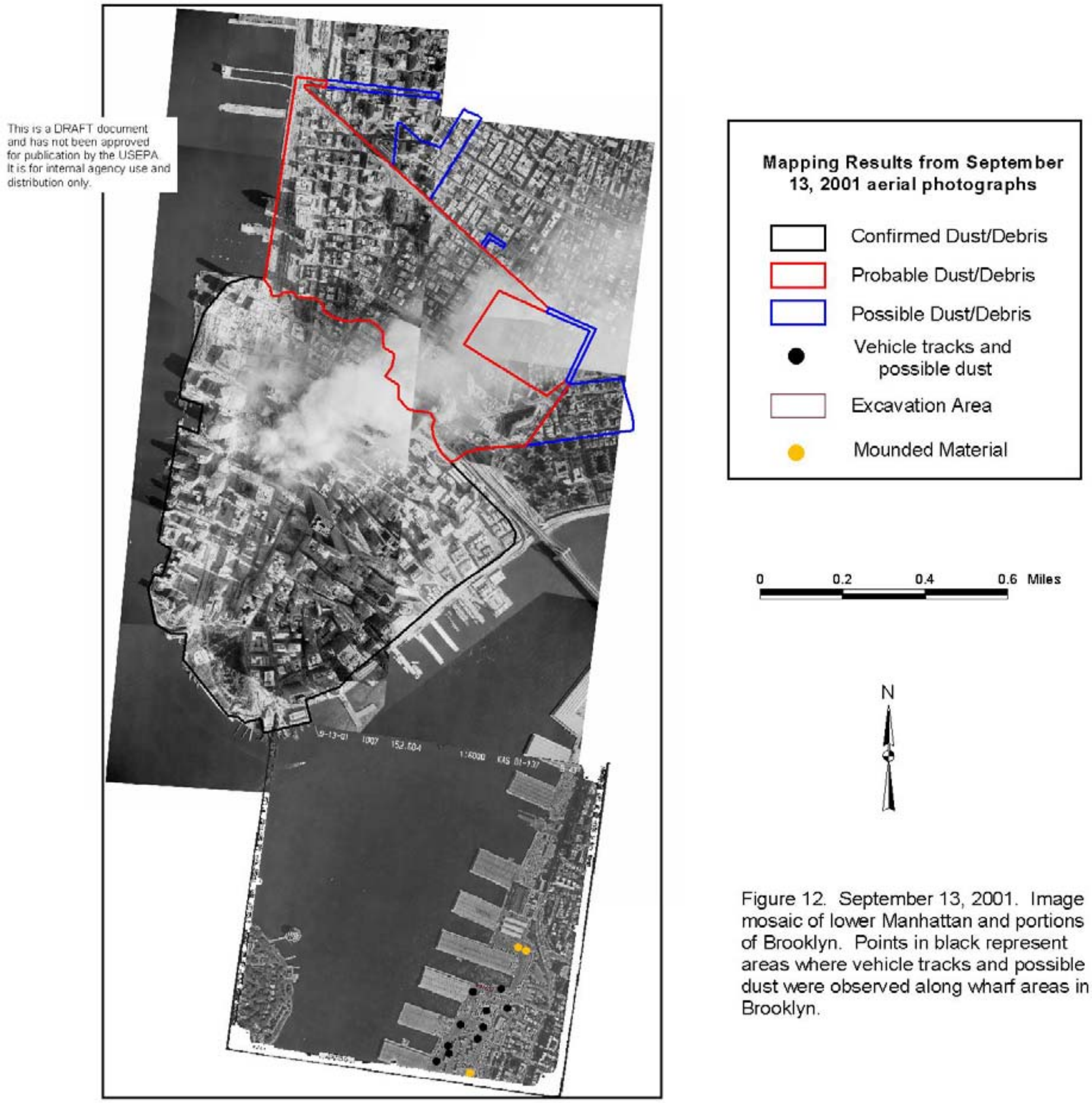


Figure 1. Display of boundaries of expected deposition based on analysis conducted by EPA's Environmental Photographic Interpretation Center (EPIC, 2004).

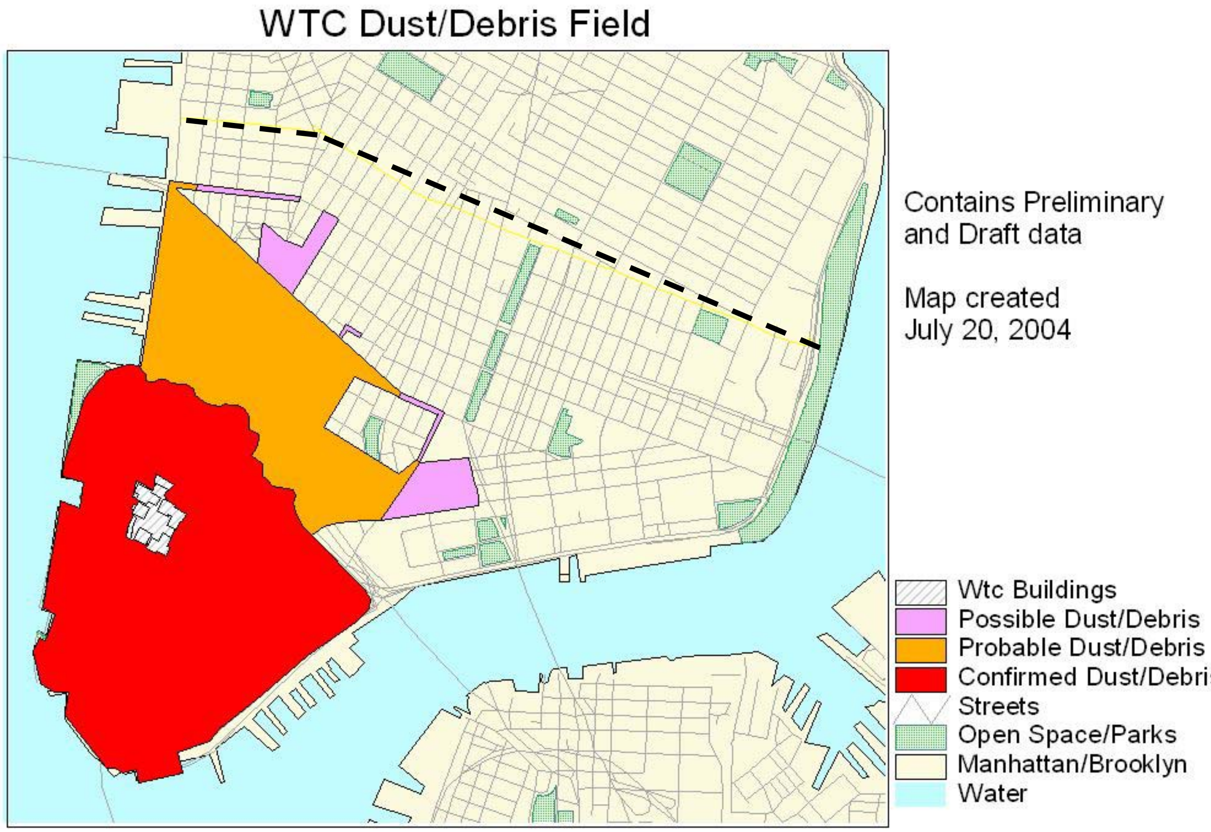
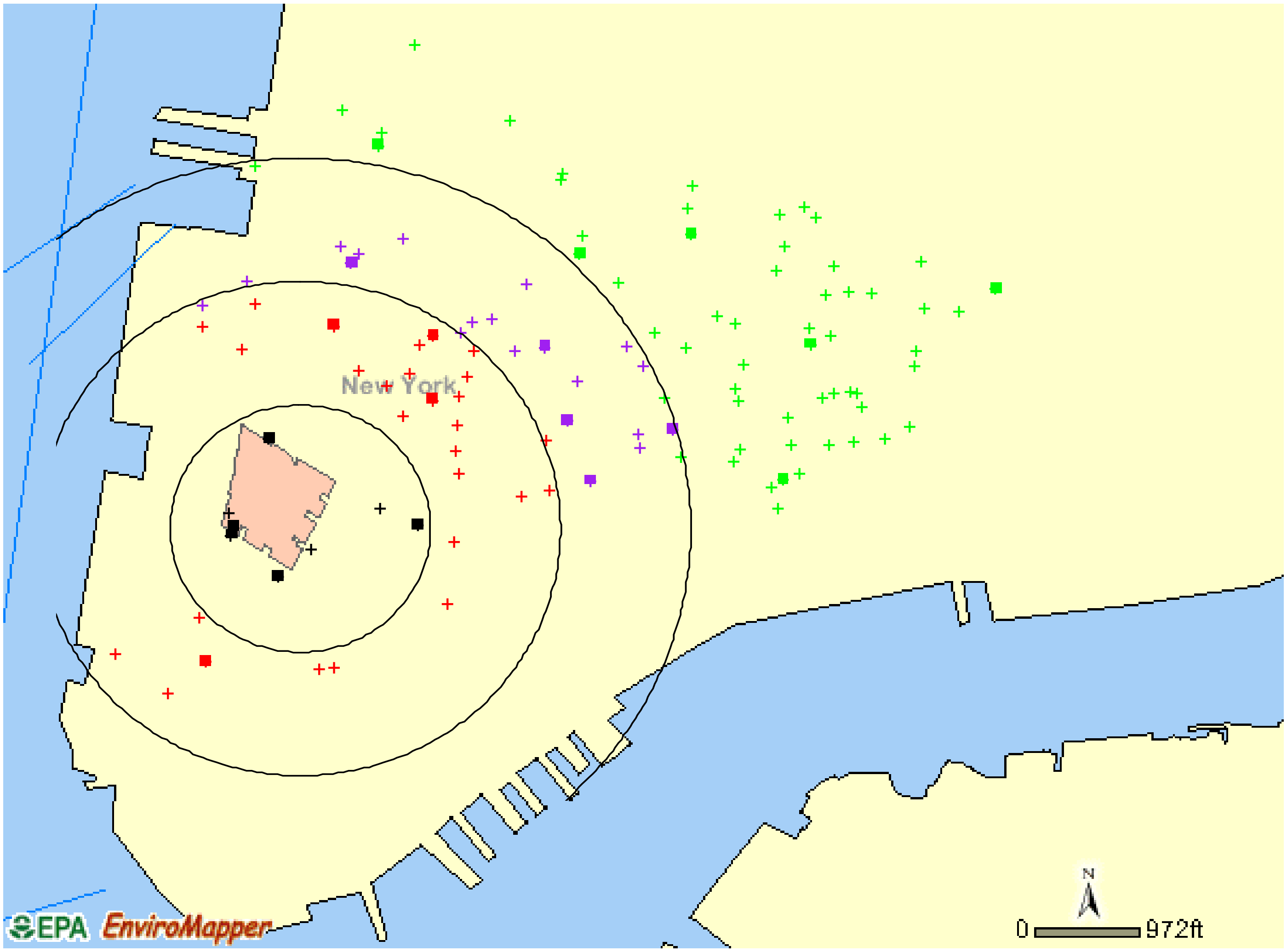


Figure 2. The study area of lower Manhattan bounded by Houston Street, shown in dashed lines, overlain on the EPIC results which are displayed in three colors: red meaning confirmed dust/debris; orange meaning probably dust/debris, and pink meaning possible dust/debris.



Key: Squares: buildings actually selected; Crosses – buildings that are eligible to be selected. Black – buildings within 0 to 500 meters of Ground Zero; Red – buildings 500 to 1000 meters; Purple – buildings 1000 to 1500 meters; and Green – buildings 1500 to 3000 meters.

Figure 3. Example of possible outcome of a spatially balanced approach to building selection (see text for a further description of this map).

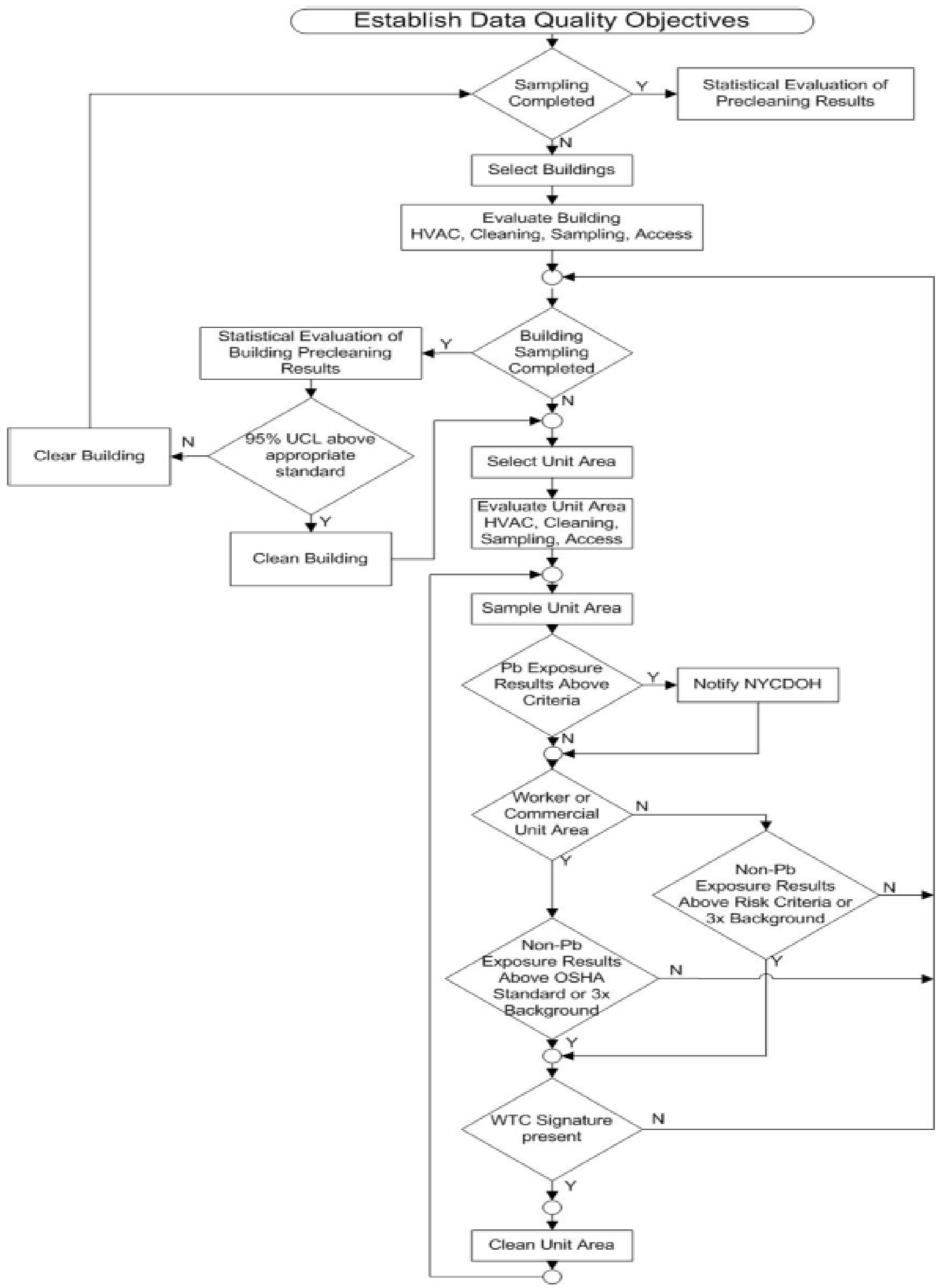


Figure 4. Decision tree to determine whether an offer will be made to clean a tested unit, as well as the building as a whole.

Table 1. Proposed Sampling and Analytical Methods for the Building Sampling Program.

Media	Sampling Points	Analytical Parameters	Sampling Method Proposed	Description	Analytical Method Proposed	Proposed Reporting Limits
Settled Dust Porous Soft Surfaces	Carpets, fabric furniture or drapery in areas of activity (living rooms, class rooms, offices, etc.) and accumulation (behind or on top of cabinets/bookcases).	Asbestos	ASTM D 5755-95	Micro vacuuming method.	ASTM D 5755-95	1000 structures/cc
		Lead	ASTM E 1973-99	Micro vacuuming method.	SW-846 6010B	2 ug/ft2
		Silica	HUD Appendix 13.1**	Micro vacuuming method.	NIOSH 7500 (XRD)	1000 ug/ft2
		MMVF	ASTM D 5755-95	Micro vacuuming method.	EMSL MSD.0300 or Equivalent	1000 f/cm2
Settled Dust Non-porous Hard Surfaces	Horizontal surfaces of tables or counters and bare floors, ceilings and walls in areas of activity (living rooms, class rooms, offices, etc.) and accumulation (behind or on top of cabinets/bookcases).	Asbestos	ASTM D 6480-99	Wipe Samples.	ASTM D 6480-99 (wipe)	1000 structures/cc
		Lead	HUD Appendix 13.1	Wipe Samples.	SW-846 6010B	2 ug/ft2
		PAHs	ASTM D 6661-01	Wipe Samples.	ASTM 6661-01/SW-846 8270C	0.150 mg/m2
		Silica	HUD Appendix 13.1**	Wipe Samples.	NIOSH 7500 (XRD)	1000 ug/ft2
		MMVF	ASTM D 6480-99	Wipe Samples.	EMSL MSD.0300 or Equivalent	1000 f/cm2
HVAC Systems	*HVAC Systems -Inlet and outlet*	*Asbestos*	*ASTM D 6480-99*	*Wipe Samples.*	*ASTM D 6480-99 (wipe)*	*1000 structures/cc*
		Lead	*HUD Appendix 13.1*	*Wipe Samples.*	*SW-846 6010B*	*.2 ug/ft2*
		PAHs	*ASTM D 6661-01*	*Wipe Samples.*	*ASTM 6661-01/SW-846 8270C*	*0.150 mg/m2*
		Silica	*HUD Appendix 13.1***	*Wipe Samples.*	*NIOSH 7500 (XRD)*	*1000 ug/ft2*
		MMVF	*ASTM D 6480-99*	*Wipe Samples.*	*EMSL MSD.0300 or Equivalent*	*1000 f/cm2*

Table 1 (continued).

Media	Sampling Points	Analytical Parameters	Sampling Method Proposed	Description	Analytical Method Proposed	Proposed Reporting Limits
HVAC Filters	*HVAC, AC, or HEPA unit filters (collection of bulk dust sample from air filters and mixing plenums).*	*Asbestos*	*Bulk Sample*	*Bulk Samples.*	*PLM NYS 198.1 followed by TEM NYS 198.4*	*1000 structures/cc*
		Lead	*Bulk Sample*	*Bulk Samples.*	*SW-846 6010B*	*2 ug/ft2*
		PAHs	*Bulk Sample*	*Bulk Samples.*	*SW-846 8270*	*<0.3 mg/m2*
		Silica	*Bulk Sample*	*Bulk Samples.*	*NIOSH 7500 (XRD)*	*1000 ug/ft2*
		MMVF	*Bulk Sample*	*Bulk Samples.*	*PLM NYS 198.1/EMSL MSD.0300 or Equivalent*	*1000 f/cm2*